Search for Associated Production of ZH-> $e^+ e^-$ + b $\bar{b}$ Final States

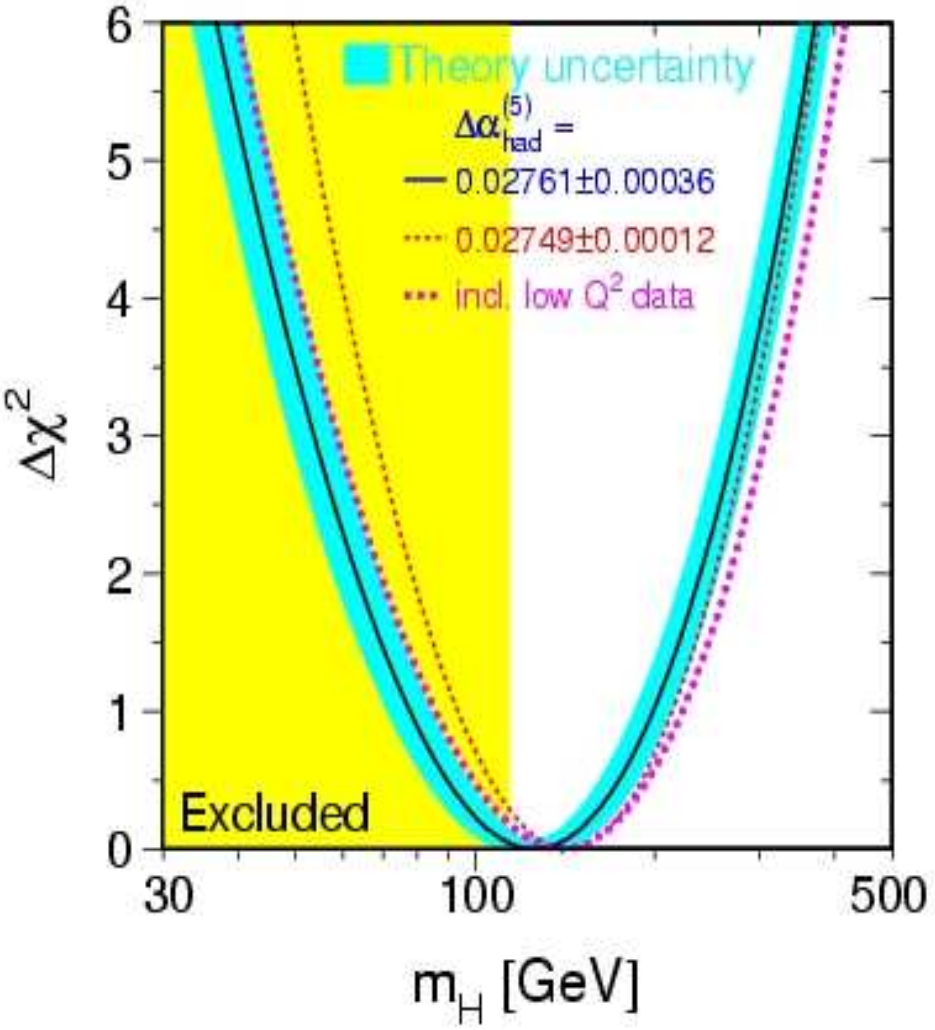
1. Higgs mechanism
2. Accelerator and Detector
3. Event Selection
4. Kinematic Distributions of electrons and jets in Z+2 jets
5. Cross section Z + n jets
6. B tagging

American Physical Society
18APR05
James Heinmiller

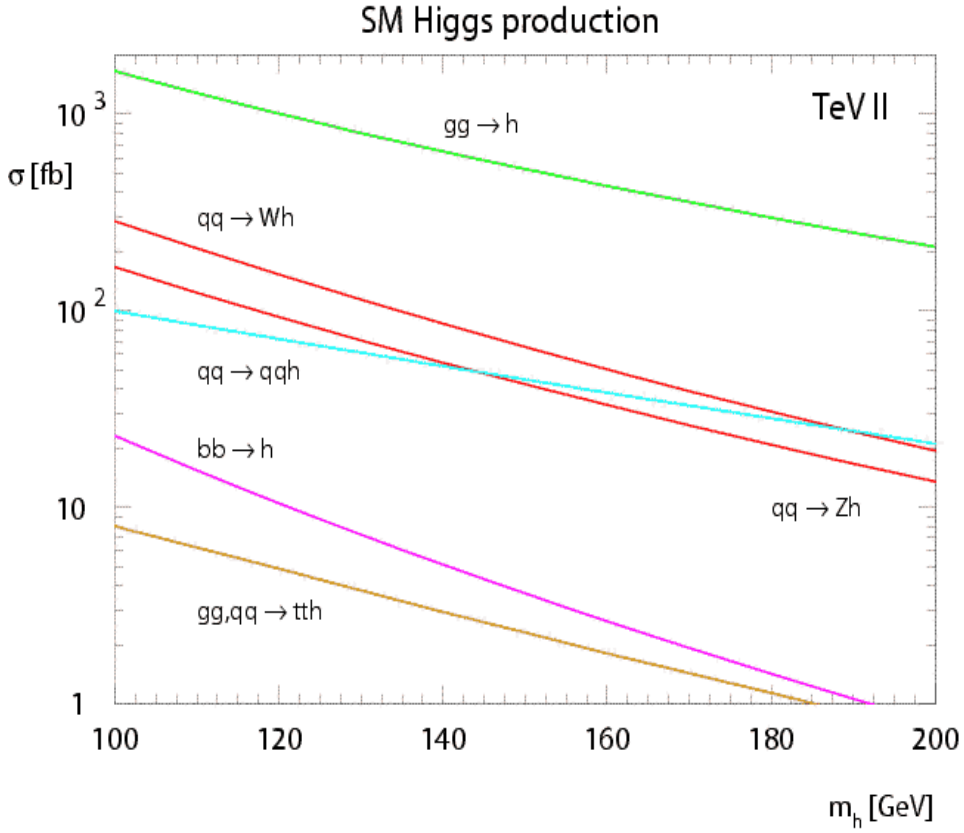
The SM Higgs in a Nutshell

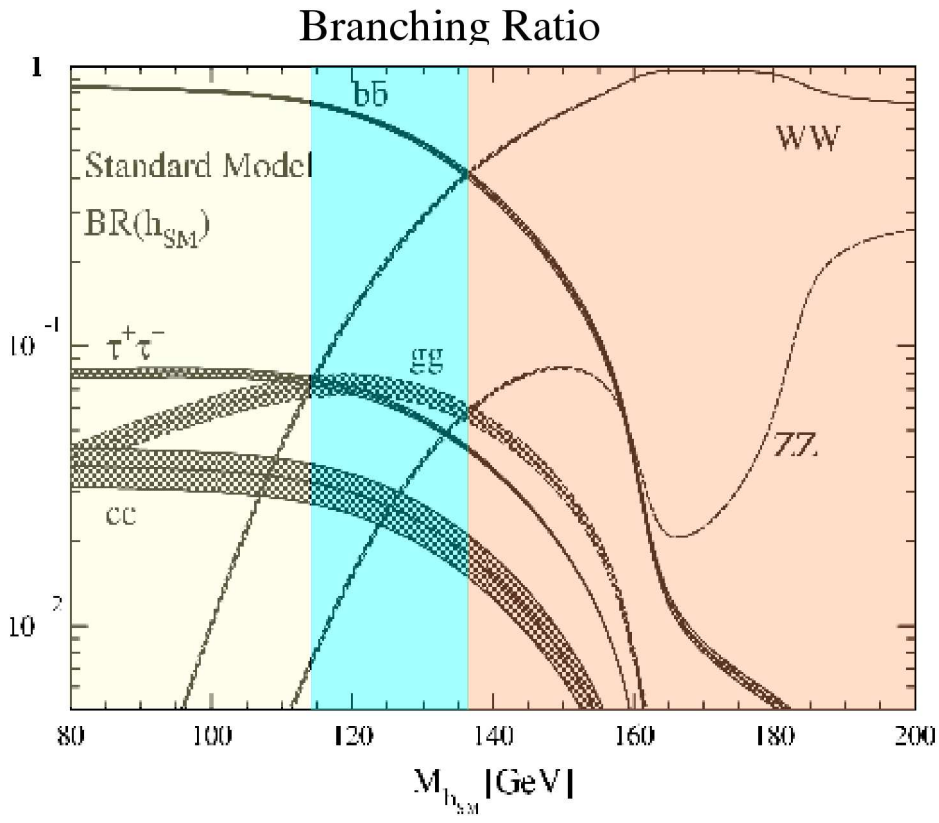
- Last missing piece of the SM
- The Higgs mechanism provides an explanation for electroweak symmetry breaking
- Gives mass to the particles of the SM
- Light SM Higgs preferred:
  - $M_H = 126\ \text{GeV}^{+73\ \text{GeV}}_{-48}$
  - $M_H < 280$ GeV @ 95%CL
  - LEP direct search: $M_H > 114.4$ GeV @ 95%CL

Global fit to precision measurements



Higgs Production and Decay





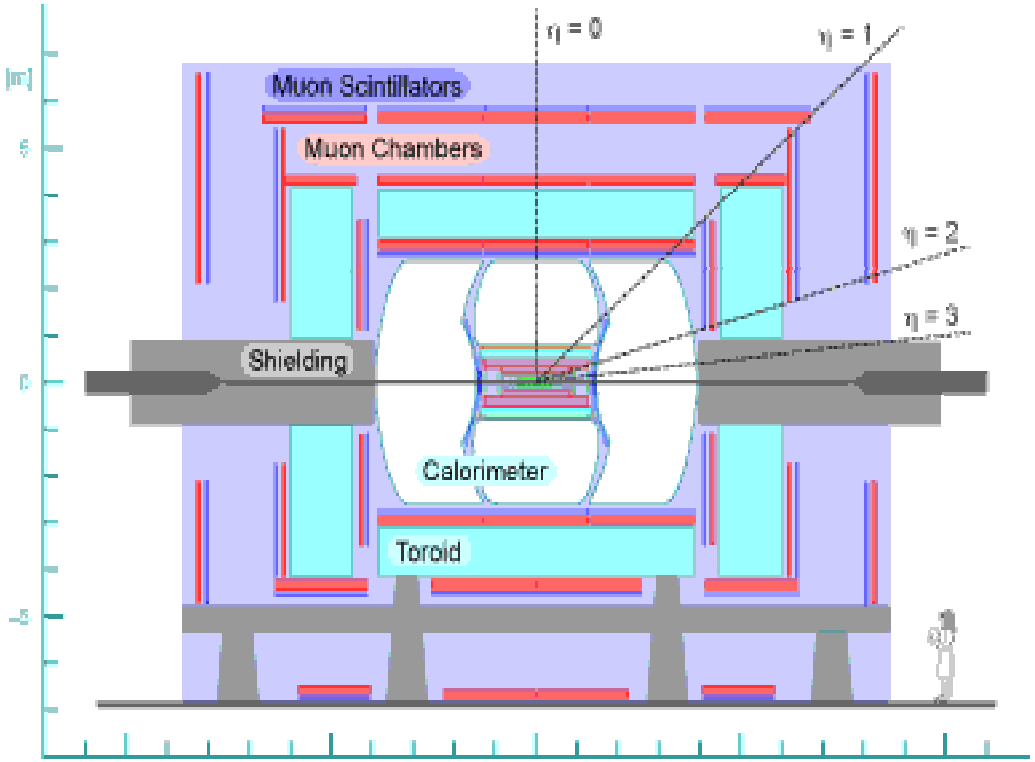
Low mass Higgs < 135 GeV

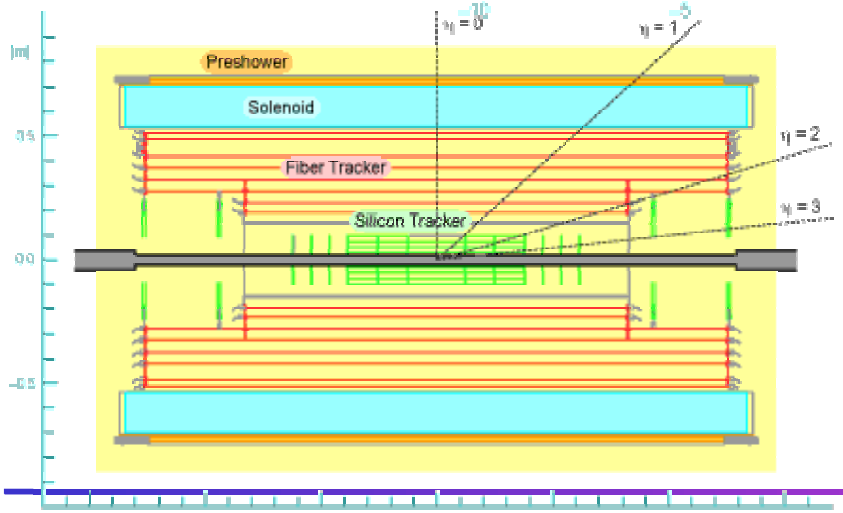
The gg->h combined with bb branching ratio is swamped by QCD

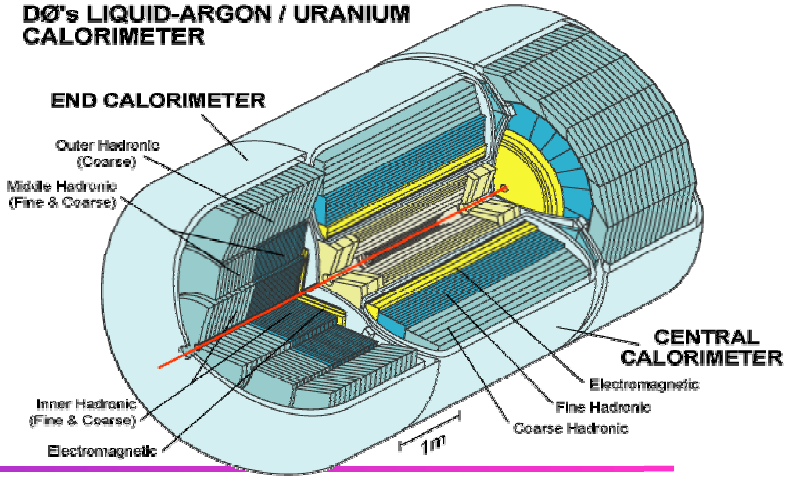
The W/Z association gives a handle on reducing background events


linac
booster
Anti proton
CDF
Main injector
Recycler
1.96 TeV
p+
p-
D0
Imagery ©2005 DigitalGlobe, EarthSat

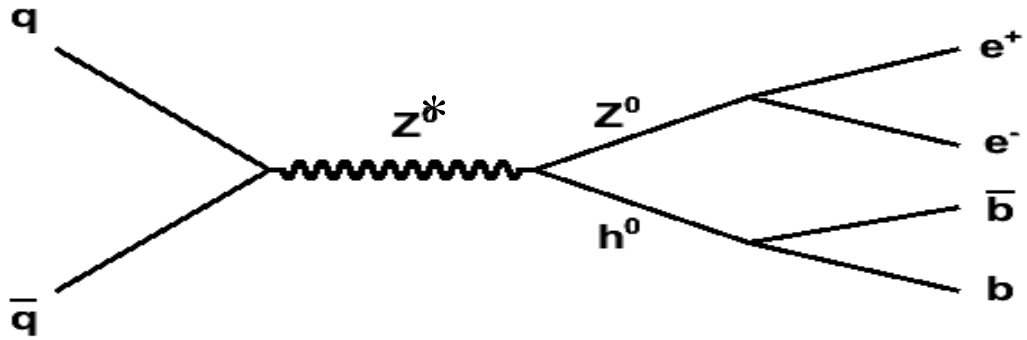
D0 Detector


η = 0
η = 1
η = 2
η = 3
Muon Scintillators
Muon Chambers
Shielding
Calorimeter
Toroid


Preshower
Solenoid
Fiber Tracker
Silicon Tracker
η = 2
η = 3


DØ's LIQUID-ARGON / URANIUM CALORIMETER
END CALORIMETER
Outer Hadronic (Coarse)
Middle Hadronic (Fine & Coarse)
CENTRAL CALORIMETER
Electromagnetic
Fine Hadronic
Coarse Hadronic
Inner Hadronic (Fine & Coarse)
Electromagnetic
1m

Event Selection



signal

p_T electrons > 25.0 GeV $-1.1 < \eta < 1.1$

p_T jets > 20.0 GeV $-2.5 < \eta < 2.5$

Luminosity 343 pb^{-1}

<u>background</u>

Z (-> ee) $b\bar{b}$

Z Z -> ee $b\bar{b}$

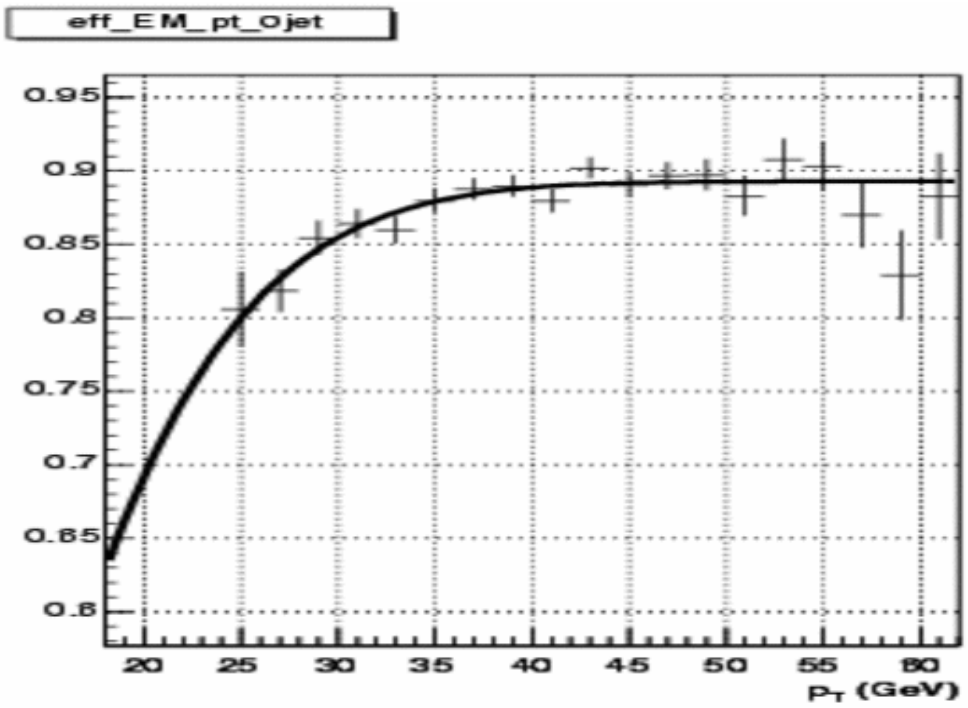
$t\bar{t}$ -> e e b $\bar{b}$

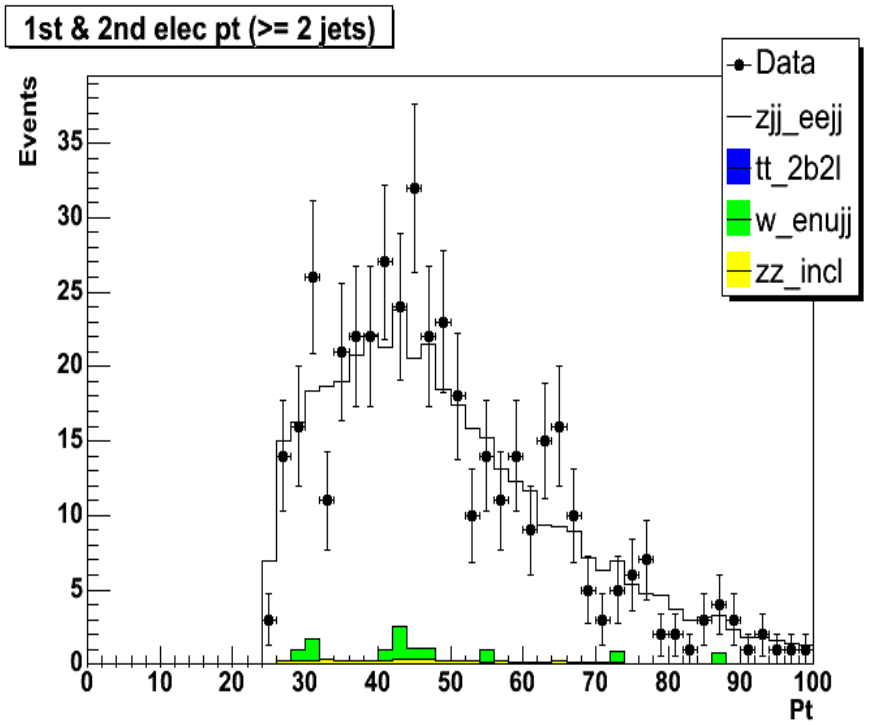
Z (-> ee) $c\bar{c}$

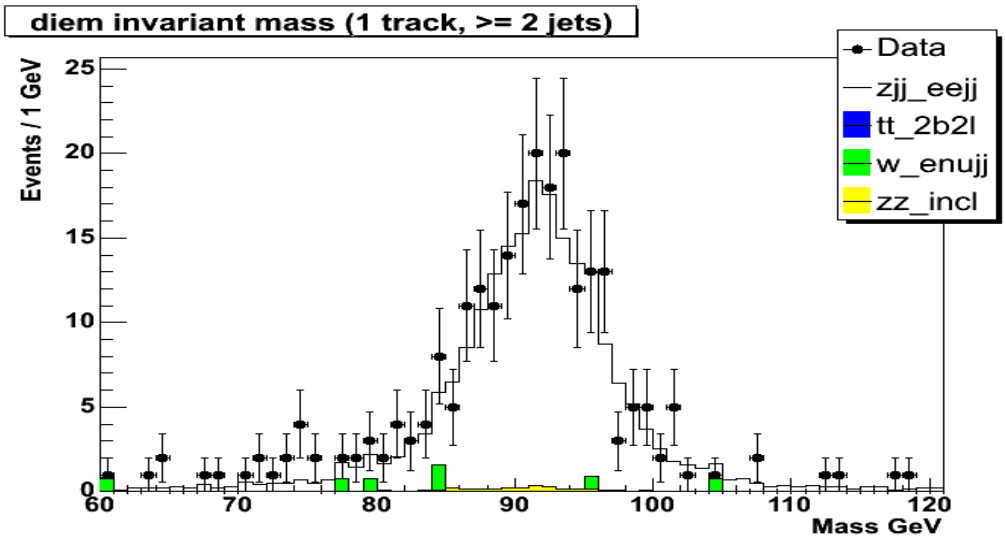
Z Z -> ee $c\bar{c}$

Z (-> ee) jj

Electrons in Z + 2 jets



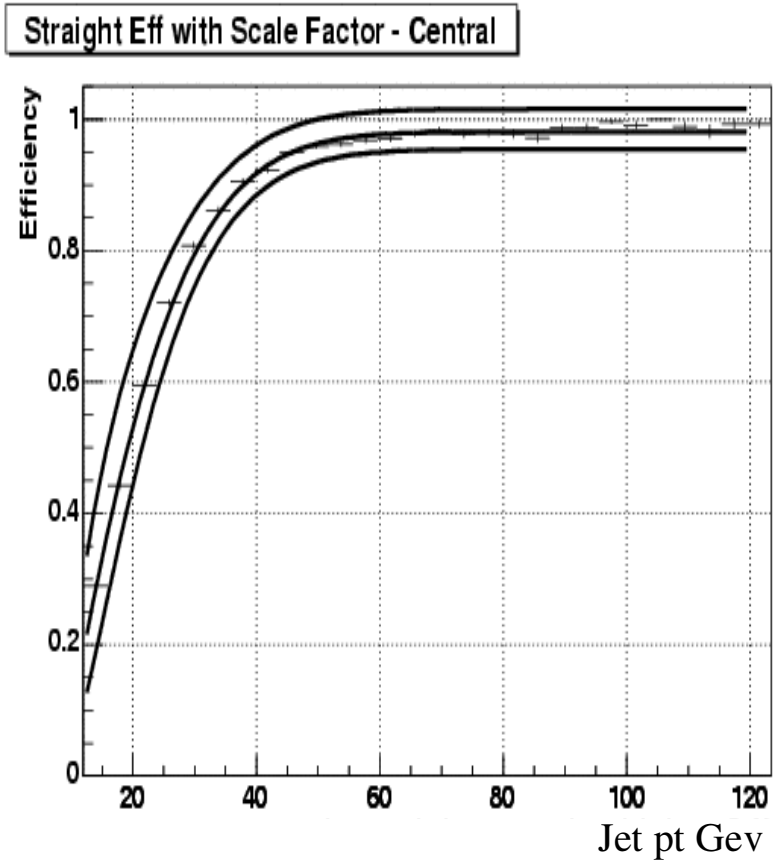




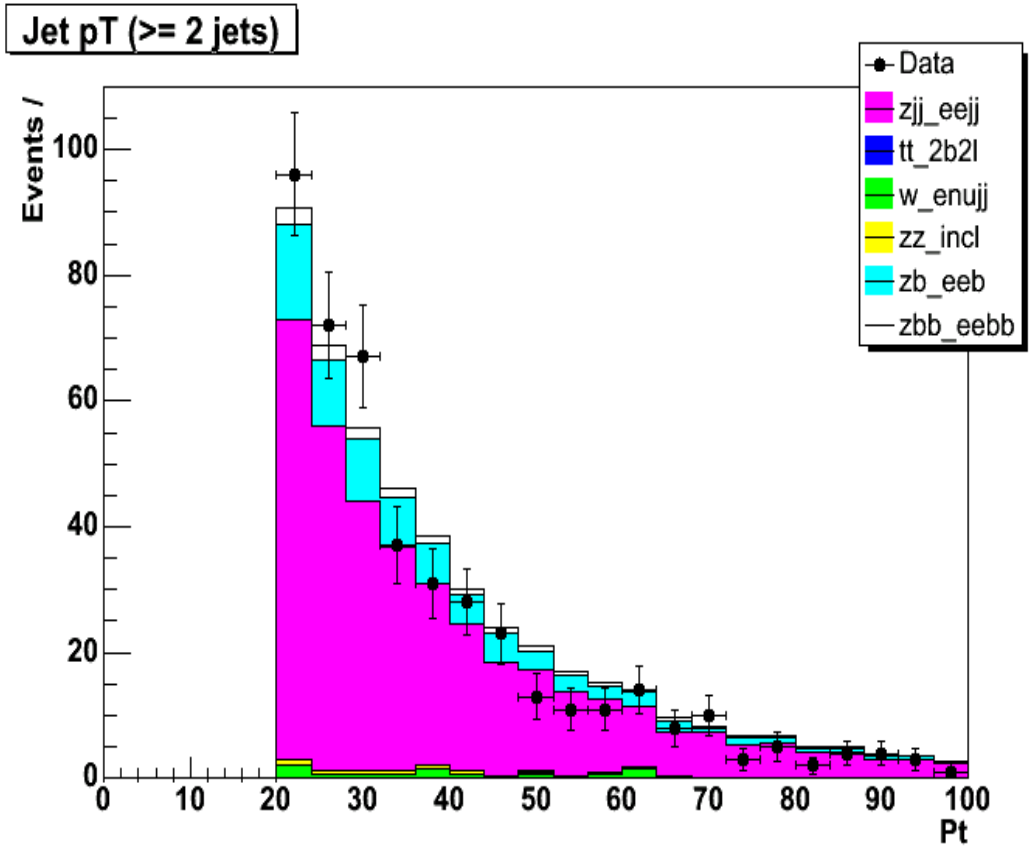
Tag and probe with Z mass

Leading electrons p_T and diem invariant mass

Jet Reconstruction Efficiency & Comparison



Jet reconstruction identification efficiency for DATA with uncertainty error bands

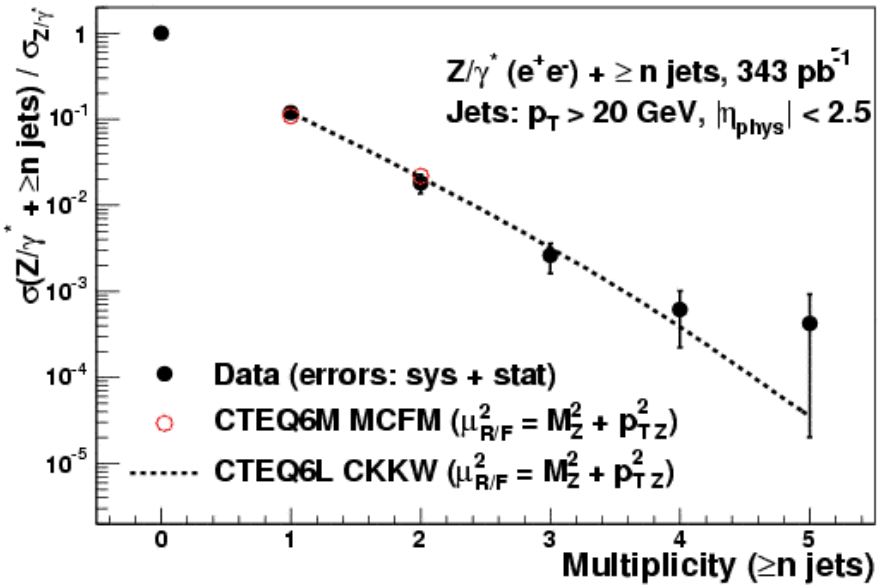


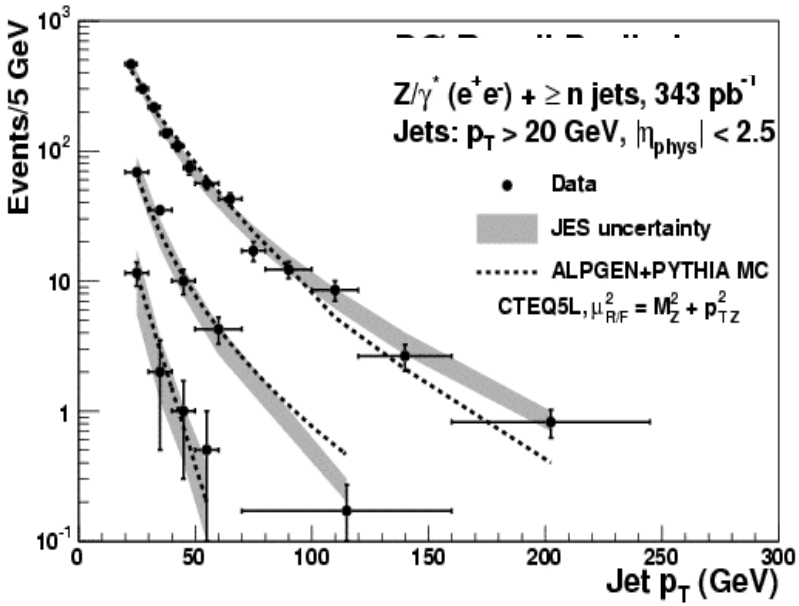
Data and Monte Carlo comparisons of Z + ≥ 2 jets

Cross Section Ratios

Z (-> ee) + jj has the largest background before B tagging

$$\sigma = \frac{(Nsignal - Nbackground)}{(L \cdot A \cdot \epsilon)}$$





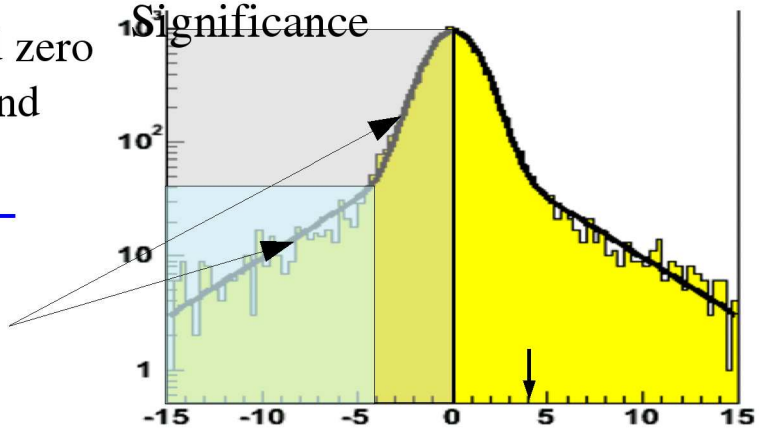
Jet Multiplicity	# of Signal Events	Z/gamma->ee+n jet cross section
≥0	18264	1
≥1	2551	**119.1 ± 3.3 (stat) ± 17.2 (sys)**
≥2	392	**18.1 ± 1.3 (stat) ± 4.5 (sys)**
≥3	64	**2.6 ± 0.52 (stat) ± 0.90 (sys)**
≥4	15	**0.61 ± 0.28 (stat) ± 0.29 (sys)**
≥5	7	**0.42 ± 0.30 (stat) ± 0.42 (sys)**

B tagging

- Jet lifetime probabilities (JLIP)
  probability that jet originated from the primary vertex by using the impact parameter information of tracks

Light jets IP are symmetric around zero
B jets are larger and positive

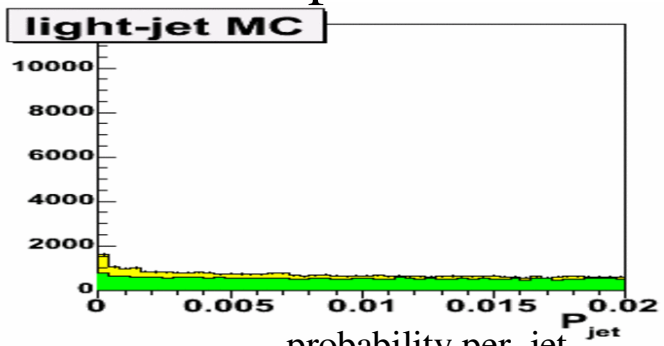
Impact Parameter (IP) Significance

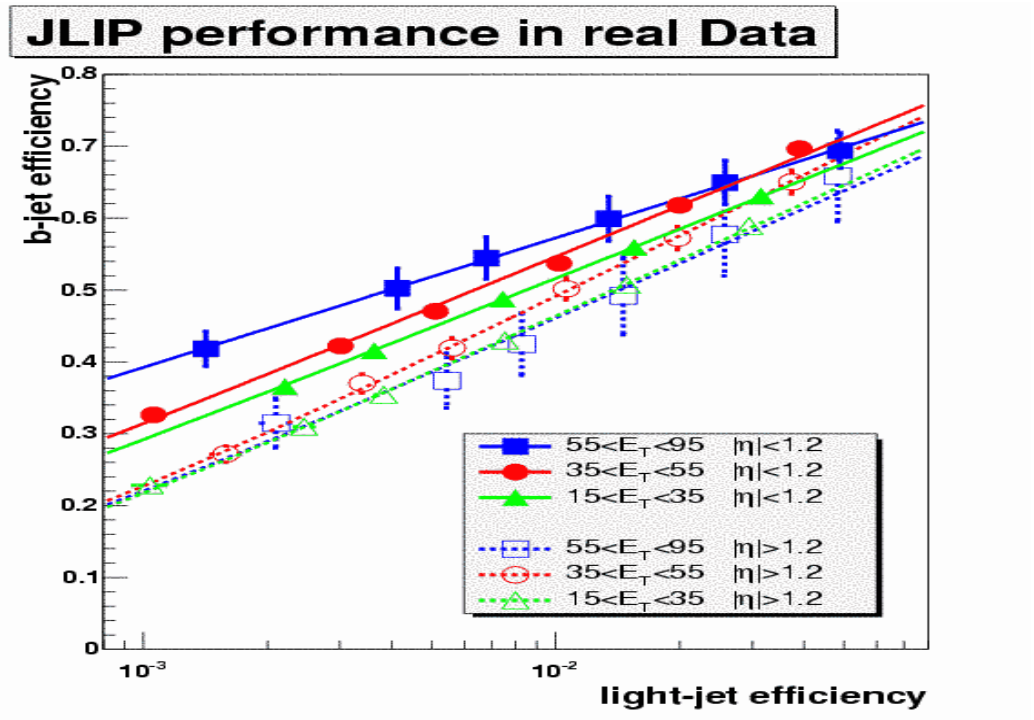


JLIP is calculated by taking the ratio of the area underneath the curves

Jet lifetime probabilities

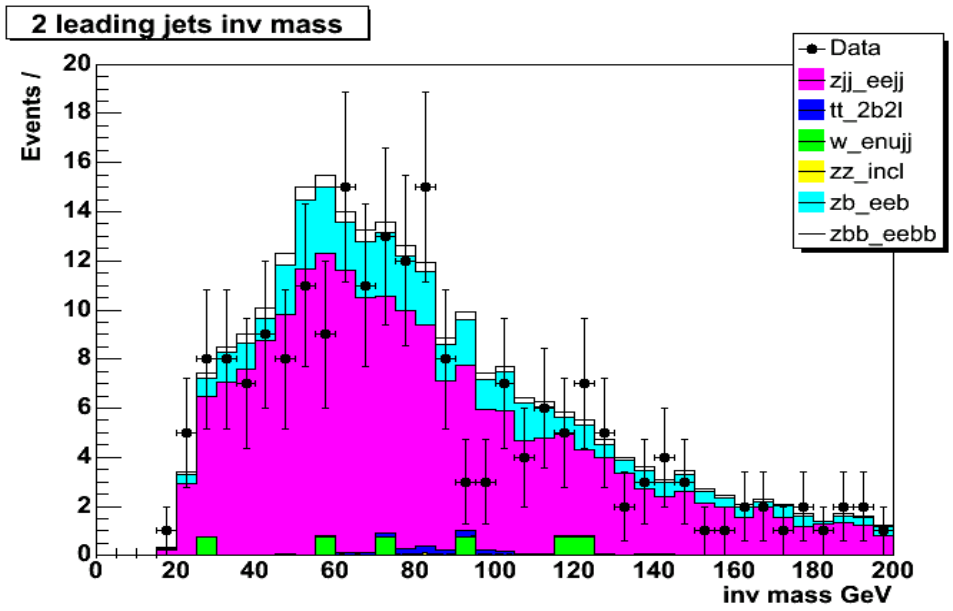
Light quarks have a flat distribution



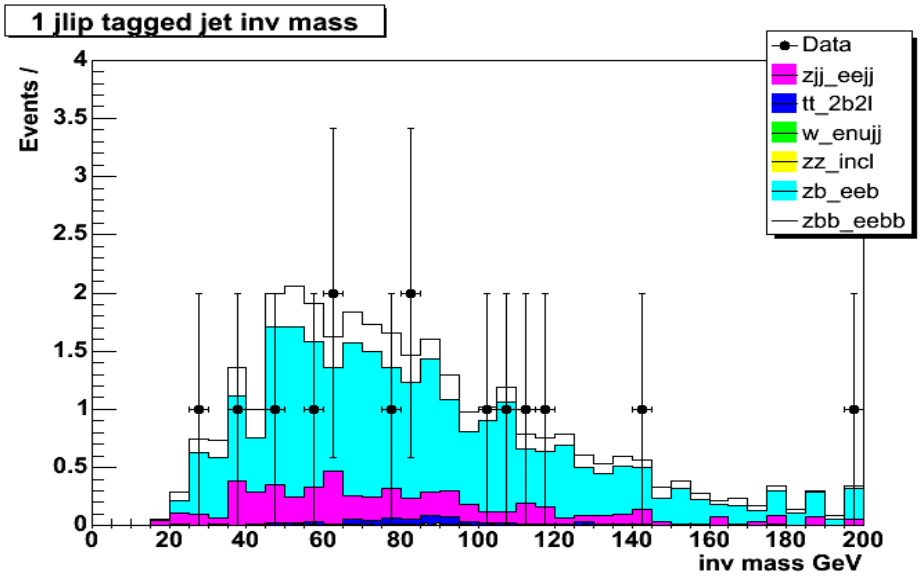


Invariant Mass Distributions

Two leading jets after Z boson selection



Requiring 1 JLIP B tag



Summary

- Properties of $Z(\rightarrow e^+e^-)$ + Jets events are being studied as a first step towards Higgs search in the $ZH \rightarrow e^+e^-$ bb channel
- Kinematic properties of events have been compared to MC simulations
- Cross Section ratios vs Jet Multiplicity have been measured and compared to theory

➢ Cross Sections for $Z(->e^+e^-)$bj and $Z(->e^+e^-)$bb are in progress